

**CLAIMS**

- 1           1.     A transcutaneous energy transfer device having an external primary coil to  
2     which energy to be transferred is applied, and an implanted secondary coil inductively  
3     coupled to said primary coil and connected to apply energy to a subcutaneous utilization  
4     device, characterized by the inclusion of a magnetic shield covering said primary winding.
- 1           2.     A device as claimed in claim 1 wherein said shield is larger than said primary  
2     coil.
- 1           3.     A device as claimed in claim 2 wherein said primary coil has a selected shape  
2     and size, and wherein said shield is of substantially the same shape as said primary coil, but of  
3     greater size.
- 1           4.     A device as claimed in claim 3 wherein said primary coil has dimensions  $x_i$  in  
2     direction  $i$ , wherein the shield has a thickness  $t$  and wherein the dimensions of the shield in  
3     direction  $i$  is  $X_i \geq x_i + 2t$ .
- 1           5.     A device as claimed in claim 3 wherein said primary coil has a generally  
2     circular shape with a diameter  $d$ , and wherein said shield has a generally circular shape with a  
3     diameter  $D$ , where  $D > d$ .
- 1           6.     A device as claimed in claim 5 wherein said shield has a thickness  $t$ , and  
2     wherein  $D \geq d + 2t$ .
- 1           7.     A device as claimed in claim 5 wherein the shield is formed of a material  
2     having a magnetic permeability relative to free space ( $\mu$ ) and has a thickness ( $t$ ), where  $t \geq D/\mu$ .
- 1           8.     A device as claimed in claim 1 wherein the shield is formed of a material  
2     having a magnetic permeability relative to free space ( $\mu$ ), has a major dimension  $X$ , and has a  
3     thickness ( $t$ ) where  $t \geq X/\mu$ .

1           9.     A device as claimed in claim 1 wherein said shield has a plurality of ventilation  
2 perforations formed therein.

1           10.    A device as claimed in claim 9 wherein said perforations are formed parallel to  
2 the magnetic field direction.

1           11.    A device as claimed in claim 10 wherein said primary coil is substantially  
2 circular, and wherein said perforations are a plurality of radial slots.

1           12.    A device as claimed in claim 9 wherein said perforations cover approximately  
2 25% to 75% of the area of the shield.

1           13.    A device as claimed in claim 12 wherein said perforations cover approximately  
2 50% of the area of the shield.

1           14.    A device as claimed in claim 12 wherein the perforations result in a reduction  
2 in  $\mu$ , for the shield which is roughly proportional to the percentage of perforation area, and  
wherein the shield thickness is increased so as to maintain the relationship  $t \propto D/\mu_r$ .

1           15.    A device as claimed in claim 12 wherein all dimensions for the perforations are  
2 less than the dimensions of the smallest coil in the device.

1           16.    A device as claimed in claim 1 wherein said shield is flexible so as to be able  
2 to conform to the contours of a patient's body.

1           17.    A device as claimed in claim 16 wherein said shield is formed of a low loss  
2 magnetic material in a flexible polymer matrix.

1           18.    A device as claimed in claim 17 wherein said shield is formed of a ferrite  
2 powder in a silicone rubber.

1 19. A device as claimed in claim 16 wherein said shield is formed of a plurality of  
2 segments of a very high permeability material connected by a porous, flexible material.

1 20. A device as claimed in claim 19 wherein the spacings between adjacent  
2 segments in a direction substantially parallel to the magnetic field direction of the primary coil  
3 is less than the dimensions of the smallest coil in the device, and the spacing between adjacent  
4 segments in a direction substantially perpendicular to the magnetic field direction is much less  
5 than the spacing in said parallel direction.

1 21. A device as claimed in claim 19 wherein said segments cover approximately  
2 25% to 75% of said shield area.

1 22. A device as claimed in claim 1 wherein said primary coil generates a magnetic  
2 field which is directed both toward and away from said secondary coil and wherein said shield  
3 is dimensioned and is formed of a material which reflects most of the magnetic field directed  
4 thereto toward said secondary coil.

1 23. A device as claimed in claim 19 wherein said segments comprises:  
2 a plurality of segments arranged in one or more concentric rings, each said  
3 concentric ring including segments of substantially the same size.

1 24. A device as claimed in claim 23 wherein said plurality of segments are  
2 constructed and arranged so as to form a gap between radially opposing segments in said ring,  
and wherein said segments further comprises a center disk shaped to fit within said gap.

1 25. A device as claimed in claim 1, wherein said shield and said primary coil are  
2 mounted together to form a primary coil assembly, and wherein a substantially impervious  
3 coating is applied to said assembly.

1 26. A device as claimed in claim 25, wherein said primary coil assembly is vinyl  
2 dip coated.

1           27.    A device a claimed in claim 1, wherein said primary coil is operationally  
2 decoupled from a drive circuit prior to physical disconnection of electrical contacts through  
3 which current is transferred from the drive circuitry to said primary coil, and wherein physical  
4 connection of electrical contacts through which current is transferred from the drive circuitry  
5 to said primary coil occurs prior to operationally coupled the primary winding to the drive  
6 circuit.

1           28.    A device a claimed in claim 27, wherein said primary coil is electrically  
2 coupled to the drive circuit via an electrical connector, wherein said electrical connector  
3 includes power transfer contacts and anti-arcing contacts, wherein said anti-arcing contacts  
4 electrically mate after and break before said power transfer contacts, said anti-arcing contacts  
5 electrically connected to control circuitry operationally interposed between the drive circuit  
6 from the primary winding.

1           29.    A device a claimed in claim 28, wherein said control circuitry is located in said  
2 drive circuitry.

1           30.    A device a claimed in claim 28, wherein said control circuitry is located in said  
2 connector.